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by Lppm upy011

Submission date: 22-Jan-2024 08:34AM (UTC+0700)

Submission ID: 2275369122

File name: turn_it_in_jtde.pdf (568.23K)

Word count: 10625

Character count: 61705

Technology Transformation, Innovation, and Digital Economy Development: Literature Review in 84 Developing Countries

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Abstract: The COVID-19 pandemic is a gateway for businesses to develop technology and embrace digitalization to remain competitive. Various results stated the important role of innovation and technology transformation as potent weapons for survival in this evolving landscape. This research will analyze the role of technology and innovation, especially in developing countries, with few articles researching this field. A systematic literature review that examined 84 articles from reputable international journals was used with a particular emphasis on developing countries. This research aimed to conduct a comprehensive analysis of existing literature by using the keywords technology, innovation, and digital economy to identify gaps and generate fresh insights. The articles were collected from ProQuest, Google Scholar, and Scopus search engines and imported into Mendeley software for analysis using Vos Viewer. The visualization results showed that SMEs were the most frequently mentioned keyword with 41 occurrences.. This research contributed by providing opportunities in the form of new paths and variables rarely used for further analysis. There were also implications for organizational management, both in profit and non-profit organizations, to enhance technological capabilities, thereby improving business efficiency and sustainability.

Keywords: Digital Economy, Innovation, Technology, Vos Viewer.

Introduction

The COVID-19 pandemic is having negative impacts across various sectors, including social, the economy, education, healthcare, and the way of life of the global community (Akkad & Mouselli, 2023; Al-Manna'ei et al., 2023; Ben Hassen, 2022; Bouzakhem et al., 2023; Carlos et al., 2022; Chinaza, 2023; Grigorescu et al., 2023; Nan & Park, 2022; Ruba et al., 2023;

Tazhibekova et al., 2023). Several research reported technology implementation in business development as a solution to environmental uncertainty and intense competition in profit-oriented organizations, government, and the education sector (Almatrodi & Skoumpopoulou, 2023; Amoah et al., 2023; Chemma, 2021; Shao et al., 2022; Ssemugenyi & Nuru Seje, 2021). This implementation is also a primary strategy for many companies when facing pandemic, serving as a tool to formulate strategies for navigating turbulence and fulfilling consumer preferences (Alawamleh et al., 2023; Almunawar & Anshari, 2022; Lontchi et al., 2023; Pasciaroni et al., 2022; Rodchenko et al., 2021). Furthermore, it expedites communication with stakeholders, streamlines asset management, reduces costs, and increases revenue (Othman et al., 2023; Pierre et al., 2022; Polas et al., 2022). From employee perspective, digital implementation in SMEs increases motivation when the technology is beneficial and user-friendly, resulting in improved performance (Uzkurt et al., 2023). Therefore, company strives to respond and adapt to changes in business plans to stay in line with the evolving times and goals (Faasolo & Sumarliah, 2022). The technology implementation will facilitate organizations in adopting strategies, including innovation to enhance productivity and meet market demands (Pea-Assounga & Yao, 2021).

The innovation process also serves as a driver for the advancement of manufacturing and construction company toward a digital economy, capable of reducing disparities as well as enhancing productivity and international competitiveness (Guang-lin & Tao, 2022; Shkabatur et al., 2022; Stojanovska-Georgievska et al., 2022). The concept is a fundamental force that facilitates the production transformation processes and economic systems within a country (Carvache-Franco et al., 2022; Casadella & Tahi, 2021; Mahmutaj et al., 2021). In addition, innovation plays a crucial role during and after the COVID-19 pandemic because the infection poses challenges to creating new business models and creative ideas in line with market needs and customer expectations (Bouzakhem et al., 2023; Nguyen et al., 2022; Valdez-Juárez et al., 2022). Open innovation becomes increasingly relevant in disseminating information to address digital disparities in a region. Even though traditional businesses rely on internal resources, this concept leans on the openness to welcome ideas from external experts (Kurmanov et al., 2022; Osorno-Hinojosa et al., 2022), enhancing company performance (Valdez-Juárez et al., 2022).

Therefore, this research identifies gaps and opportunities for future analyses related to technology implementation, innovation, and digital economy in developing countries to answer the following questions:

1. How can research on technology, innovation, and digital economy be clustered?
2. What are the most published research trends?
3. What topics provide opportunities for future research?

Technology and innovation remain key factors in addressing competition and environmental changes in SMEs. Many previous research explored the concept of innovation with various supporting variables, such as internet banking (Pea-Assounga & Yao, 2021); knowledge diffusion (Al-Mannaie et al., 2023); company size (Carvache-Franco et al., 2022) e-commerce (Valdez-Juárez et al., 2022), which enhances performance (Ureña-Espailat et al., 2022). Several research attempts to connect technology implementation with employee competence, financial resources (Amoah et al., 2023) project success (Kamdjoug, 2023) entrepreneur orientation (Al-Hakimi et al., 2021). Furthermore, none of the research has used digital economy as a variable. The development of digital economy is a condition where organizations or governments begin to shift the strategies to digital technology to improve efficiency (Guang-lin & Tao, 2022). This research will summarize all through a literature review method to identify new novelties.

The development of technology, innovation, and digital economy in developing countries was analyzed because: 1) the ability to exploit technology was significantly different from developed countries (Pea-Assounga & Yao, 2021); 2) the COVID-19 pandemic prompted small businesses in developing countries to use technology and innovate significantly (Lontchi et al., 2023); 3) developing countries faced barriers in the innovation process due to limited resources, information, and an inability to bear the risk of failure (Carvache-Franco et al., 2022; Hart et al., 2022; Kamdjoug, 2023); 4) the literature development on this field is slow due to low technology adoption rates (Amoah et al., 2023); 5) many variables did not have a significant impact on technology implementation, such as risk-taking (Polas et al., 2022); complexity and relative advantage (Amoah et al., 2023); compatibility (Alshaher et al., 2023); competitive pressure (Justino et al., 2022; Nguyen et al., 2022).

Related Works

This research is carried out by reviewing various results, specifically in developing countries, facing different resource limitations in technology implementation (Amoah et al., 2023). In this section, the results will be analyzed from various developing countries based on the keywords to obtain a general overview of opportunities for further research.

Technology Transformation

Technology transformation and organizational capacity pose serious challenges in many developing countries (Almatrodi & Skoumpopoulou, 2023; Oubrahim et al., 2023). Furthermore, e-commerce and artificial intelligence have altered the behavior of entrepreneurs in India, SMEs in Libya (Chatterjee et al., 2021; Omar & Elmansori, 2021), as well as the perspectives of the public sector in Tanzania, and traditional companies in Azerbaijan, compelling companies to innovate in marketing, specifically during the pandemic

(Shao et al., 2022). The concept offers new hope for SMEs in Mexico to compete both locally and globally (Valdez-Juárez et al., 2022), enhances efficiency, addresses environmental uncertainty, increases competitiveness, and ensures the survival of several SMEs in Russia, Serbia, El Salvador, Uzbekistan (Akberdina et al., 2023; Cvijić Čović et al., 2023; Flores-Hernández et al., 2022; Tuychiev, 2022), and performance in Tunisia (Bellakhal & Mouelhi, 2023). Meanwhile, financial technology, as part of technological advancement, has greatly assisted new entrepreneurs in Cameroon and Zambia in entering the market due to the flexibility and efficiency (Lontchi et al., 2023; Nan & Park, 2022). The concept also provides many benefits for assessing risk in the financial company in South Sudan (Kshetri, 2021).

In the current era of globalization, retail company in Thailand and SMEs in Ghana are increasingly adopting modern technology to significantly increase business growth. Social media is one form of technology used to bridge the gap between businesses and consumers in Angola and banking customers in Zimbabwe (Amoah et al., 2023; Justino et al., 2022; Kaondera et al., 2023; Nguyen et al., 2022). Moreover, the digital transformation conducted in Pakistan and Rwanda provides new directions and pathways for further digital innovation, enhancing the competitiveness and sustainability of SMEs in Indonesia (Budiarto et al., 2023; Naicker & Nsengimana, 2023; Sarfraz et al., 2022), including in the digital agriculture value chain of South Africa (Smidt & Jokonya, 2022). In Tonga, the sustainability is influenced by the attitude within company, and this is affected by external factors (Faasolo & Sumarlah, 2022). As a developing country, rapid technological changes pose a challenge in the Democratic Republic of Congo. Therefore, a change in management with a focus on improving human resources is the best solution (Kamdjoug, 2023). Different results are shown in Oman, where technology transformation, digitalisation and the use of e-commerce influence SMEs operational efficiency on performance. The performance of company is more optimal when SMEs use technology, specifically when facing the COVID-19 pandemic (Mishrif & Khan, 2022).

Several results use the term "technology," as exemplified by research in the Democratic Republic of Congo conducted by Kamdjoug (Kamdjoug, 2023). This research adopted a quantitative method with 229 managers from SMEs to examine the impact of management changes and IT strategy on project success and company performance. The results showed that project objective, team expertise, and IT strategy impact project success. Meanwhile, three other variables, namely communication, management support, and stakeholder acceptance, did not affect project success. The results from this research in the Democratic Republic of Congo were intriguing because the running of the business of most SMEs was less than 5 years, making the digital transformation process challenging. To achieve success, SMEs need high-quality resources and the ability to translate the company strategy and objectives.

Innovation

Innovation is a company tendency to discover new ideas that lead to the development of new products or services to enhance customer satisfaction. The development of new technology poses challenges for businesses in Trinidad and Tobago and Uganda (Eton et al., 2021; Mohan et al., 2021) as well as for small businesses due to limited resources. However, it is the best solution as a powerful weapon to compete in the market (Chemma, 2021). Research conducted in Kuwait, Mauritius, and Somalia stated that collaboration between academia, company, and the government was crucial for developing innovation as a future challenge (Daka & Siad, 2021). Academics design programs for company, while the government provides effective policies and a conducive business environment (Arman & Al-Qudsi, 2022; Roopchund, 2023). These results are supported by research in Malaysia and Moldova, where digital capability and government support enhance SMEs innovation and competitiveness (Larisa et al., 2022; Teoh et al., 2023). Results in Argentina explained that innovation is key for the hotel sector to survive during the COVID-19 pandemic (Pasciaroni et al., 2022) and improve the performance of the textile company in Pakistan and Liberia, as well as SMEs in the Republic of Congo, Ecuador, and Kosovo (Mahmutaj et al., 2021; Sarfraz et al., 2022; Sumo et al., 2022).

The research conducted in Madagascar, Bahrain, and the Philippines showed that innovation is crucial for company. Therefore, managers must create an environment where new knowledge is continually developed, and infrastructure is available to facilitate the development of new ideas (Al-Manna'ei et al., 2023; Bayudan-Dacuyucuy & Dacuyucuy, 2022; Hart et al., 2022). SMEs should compete vigorously in Bangladesh due to the rapidly changing environment to survive (Polas et al., 2022). Results in Brazil, Bolivia, Chile, and Nigeria explained that limited resources hindered innovation (Shamaki et al., 2022; Vila, 2022; Zapata & Orellana, 2022). Consequently, government support is needed to enable the production of new products, processes, and innovative marketing methods, enhancing productivity and creating jobs (Castella et al., 2022; Shkabatur et al., 2022). Lack of knowledge, financial resources, and market information have driven many companies in Ecuador and Nepal to innovate significantly (Carvache-Franco et al., 2022; Rajbhandari et al., 2022).

Based on the keyword 'innovation' used in several previous studies, various diverse conclusions have been drawn. For example, the results in Ecuador on 6,275 companies in various sectors using a quantitative method (Carvache-Franco et al., 2022). The research aims to analyze 10 factors that potentially hinder companies from innovating in process and product. The results indicate that there are 6 and 8 factors hindering product and process innovation. The research is interesting because demand uncertainty does not affect innovation, meaning that company strategies still focus on internal factors such as finances

and knowledge. Meanwhile, external factors such as market barriers are not the main target for companies.

Digital Economy

Digital economy is a concept that integrates production methods with information technology, including digital platforms. Therefore, it requires technology (digital technology and digital innovation) to break the constraints of space and time, accelerating business processes in companies (Błaszczuk et al., 2023; Guang-lin & Tao, 2022). Company is making extensive use of technology because the concept can transform business strategies and processes, products and services, and the capabilities of digital economy environment (Błaszczuk et al., 2023; Pierre et al., 2022). Compared to traditional management, digital economy can stimulate company growth, expand markets, enhance competitiveness, and change economic structure (Rodchenko et al., 2021). As an integration of information technology, the concept offers new strategic options for company transformation in China. This is because digital economy can break spatial and temporal limitations, contributing to growth (Guang-lin & Tao, 2022). Furthermore, the development of technology integrated with business operations in Morocco and Iran facilitate the flow of supply chain information, reducing waste, improving flexibility, and speeding up decision-making (Khodaparasti & Garabollagh, 2023; Oubrahim et al., 2023).

Several new startups (98% SMEs) in Jordan have made significant use of technology and are considered agents of change because they effectively generate new products and services, absorb labor, and stimulate digital economy growth (Alawamleh et al., 2023). Technology advancement, such as cloud technology, will continue to accelerate because it is easily accessible from anywhere. Therefore, the role in the development of digital economy in Kazakhstan, Thailand, and Iraq is highly significant (Alshaher et al., 2023; Kurmanov et al., 2022; Sastararuji et al., 2022). In line with several examinations in Romania for education institutions, Sri Lanka for SMEs, and Cambodia for the government prove that human resource capabilities and technology expedite the transformation process towards a digital economy (Grigorescu et al., 2023; Savuth & Sothea, 2023; That sarani & Jianguo, 2022).

The results related to digital economy research show that the concept is very important for development. Therefore, the government should intervene in the form of policies in this direction (Grigorescu et al., 2023; That sarani & Jianguo, 2022). Based on the results of various previous analyses, there are no articles that specifically use digital economy as a variable to be tested. However, the importance of the concept was explained to support progress in developing countries.

Data and Methodology

This research uses a qualitative method with a Systematic Literature Review (SLR) to find answers to the three questions mentioned in the previous section. In the pre-analysis, only one article that used the SLR method focused on agriculture in South Africa (Smidt & Jokonya, 2022). The keywords are 'digital development,' 'Small-scale farmer,' 'Agriculture value chains,' 'framework,' 'institution,' 'innovation.' This research was divided into five stages: 1) formulating the problem; 2) collecting data and literature; 3) evaluating the quality of articles; 4) conducting analysis; 5) presenting and interpreting the results of the analysis. The same steps were followed, starting with problem formulation in the introduction section, and then gathering articles using keywords, presented in the method.

Step 1: This research was conducted by using the keywords "technology," "innovation," and "digital economy," followed by the inclusion of the names of developing countries. According to the IMF (International Monetary Fund), there were 152 developing countries worldwide, resulting in 152 times searches using the ProQuest search engine. This research was restricted to scholarly journals indexed in Scopus with the document type being articles within the timeframe of 2021-2023 during the COVID-19 pandemic. Based on the ProQuest search engine, 39 articles from 39 countries were found but 4 were not indexed in Scopus, leaving 35 usable. Furthermore, step 2 included searching for the remaining 117 countries on Google Scholar and Scopus with 117 x searches, yielding 49 articles from 49 developing countries. The total number of articles obtained from ProQuest and Scopus search engines was 84 from 84 developing countries. In cases where multiple articles pertained to the same subject (1 country), 1 was selected based on the criteria of the latest year, the highest quartile, and the most keywords. Several results were not used as subjects of analysis since more than 1 country was discussed. The final step included processing the 84 articles in the Mendeley software and then exporting the data into an RIS file.

The analysis using Vos Viewer yielded the number of occurrences of keywords = 2 out of 292 and 33 meet the thresholds. Therefore, this research will only consider keywords that appear a minimum of 2 times or are used in at least 2 papers. The total number of keywords based on the analysis is 292, which Vosviewer then categorizes into 33 as shown in Table 4. The final result of the analysis includes the number of clusters and a visualization of the results, showing the relationships between keywords or variables used. The results showed that there were 60% SMEs and 40% non-SMEs (industries, government institutions, education institutions) among the types of businesses. Based on the method used, 64% were quantitative, while 36% were qualitative (Table 1). Table 2 provides categorization based on journal publication year and quartiles according to Scopus.

Table 1. Analysis Results Using Crosstab

Types	Quantitative	Qualitative
SMEs	35	16
Non-SMEs	17	16
Total	52	32

Table 2. Journal Quartiles by Year

Quartile	2021	2022	2023
<25%	-	3	2
25-50%	3	6	2
50-75%	7	12	11
>75%	3	22	13
Total	13	43	28

Results & Discussion

Figure 1. is the result of clustering using VosViewer to answer research question number 1, namely clustering research on technology, innovation, and digital economy. The results show that there are 8 clusters (the largeness of the dot in the figure is directly proportional to the number of keywords used). The main keywords of clusters 1, 2, 3, 4, 5, 6, 7, and 8, with red, green, blue, yellow, purple, light blue, orange, and brown colors are digital transformation, SMEs, circular economy, Covid-19, developing countries, open innovation, innovation, and technology, respectively.

This systematic literature review examined 84 articles discussing technology transformation and innovation in developing countries using 2 occurrences to obtain 33 related keywords. The frequency of keywords and link strength (Table 4) served as an entry point for future research opportunities.

The second research question about publication trends can be shown in Tables 3 and 4. In Table 4, the most used keywords are SMEs (cluster 2) while Table 3 shows (SMEs; SEM; Artificial intelligence; TAM; Financial inclusion; E-commerce; Entrepreneurial orientation). In Cluster 2, the number of occurrences for SMEs is 41 with a total link strength of 76, indicating that this theme has been extensively studied by previous research. In Cluster 1, the number of occurrences for Human capital is 2 with a total link strength of 4, meaning there is an opportunity for further exploration of the human capital variable discussed in the clustering discussion.

The third question about topics is analyzed based on each cluster serving as an opportunity for future research. To obtain new ideas, each cluster (clusters 1-8) will be linked to others as follows:

Cluster 1: In Cluster 1, *digital transformation* is the most frequently used keyword with 11 occurrences and a link strength of 12. The results indicate that management capability enhances digital transformation process and has an impact on technology innovation (Guanglin & Tao, 2022), including customer bank management convenience (Kaondera et al., 2023), leading to improved performance and sustainability (Budiarto et al., 2023; Sarfraz et al., 2022). Human capital has an impact on digital transformation (Rodchenko et al., 2021), enhancing supply chain performance (Oubrahim et al., 2023). These results have potential connections to Cluster 4 (Bouzakhem et al., 2023), artificial intelligence, and acceptance model theories in Cluster 2 (Chatterjee et al., 2021; Polas et al., 2022). Furthermore, the relationship between digital transformation and innovation can be tested with the role of the government, as shown in Cluster 2 (Rajbhandari et al., 2022). The description of some previous results can be explained by creating a new model that combines several previous research variables. Innovation variables are used as the first step by finding supporting factors such as management ability and digital transformation (Guanglin & Tao, 2022) as well as government intention (Rajbhandari et al., 2022). Furthermore, it is a challenge for future research to determine theories connecting digital transformation with government intervention to build a mediating relationship.

Cluster 2: In Cluster 2, “SMEs” is the keyword with the highest occurrence, namely 41, and a link strength of 76. In this cluster, some research emphasizes the importance of financial inclusion, digital finance, and technology adoption in enhancing the growth and performance of SMEs (Eton et al., 2021; Thathsarani & Jianguo, 2022). Other results explain the implementation of technology digitalization in increasing employee motivation and performance (Uzkurt et al., 2023). In Cluster 1, digitalization can strengthen the impact of innovation on organizational performance (Sarfraz et al., 2022). Additionally, the research by (Polas et al., 2022; Rajbhandari et al., 2022; Sharma et al., 2022) on knowledge of artificial intelligence related to technology adoption with the role of the government as mediation can be linked to entrepreneurship and digitalization in Cluster 5 (Maryia & Maribel, 2022; Shkabatur et al., 2022) and Cluster 1 (Pierre et al., 2022). Building a new model in this cluster can be started with the impact between technology and SMEs performance (Thathsarani & Jianguo, 2022) as well as innovation (Sarfraz et al., 2022). The new model developed is to test the mediation impact between technology implementation and innovation on performance.

Cluster 3: Cluster 3 consists of 4 keywords, namely *circular economy*, *competitive advantage*, *business strategy*, and *sustainability*, each with 2 occurrences. Results in this cluster show (Amoah et al., 2023) that technology influences social media implementation and enhances sustainability in SMEs. Additionally, sustainability is an outcome of Circular Economy practices (Khodaparasti & Garabollagh, 2023). Different results indicate that

external factors affect internal factors, enhancing sustainability (Faasolo & Sumarliah, 2022). For example, (Valdez-Juárez et al., 2022) stated that e-commerce, business strategy, and innovation improved the performance of SMEs. In Cluster 2, the application of technology is influenced by artificial intelligence knowledge (Polas et al., 2022). Various results above can be related to the keyword *competitiveness* in Cluster 7 (Teoh et al., 2023; Tuychiev, 2022).

The overview of the results can be explained by using a model that explains the impact of business strategy and e-commerce on performance (Valdez-Juárez et al., 2022). The opportunity carried out is to build a new model by connecting e-commerce, performance, and sustainability using research developed by (Amoah et al., 2023).

Cluster 4: In Cluster 4, COVID-19 is the most frequently used keyword with 12 occurrences and a link strength of 20. In this cluster, (Bouzakhem et al., 2023) explained different factors impacting the performance of SMEs employees. Furthermore, employee performance is related to Cluster 8, as the improvement of SMEs performance (Lontchi et al., 2023; Pea-Assounga & Yao, 2021). Another research using a case study method found various factors affecting knowledge sharing, such as human resources, processes, and organisational culture (Carlos et al., 2022). However, the variable only has an impact on innovation when the company is in a low manufacturing technology environment (Bianchi & Machado, 2021). This research is further developed by conducting a more in-depth analysis based on strategy and company type, as in Cluster 6 (Pilav-Velic & Hatidza, 2021).

A more in-depth explanation of this cluster can be started by examining the factors impacting employee performance, namely resilience and empowerment (Bouzakhem et al., 2023). Meanwhile, others examine the impact of internet banking and innovativeness on employee performance (Pea-Assounga & Yao, 2021). Future research interested in this theme can establish a mediating relationship between internet banking, empowerment, and performance by using relevant theories.

Cluster 5: In Cluster 5, the keyword *developing countries* has 7 occurrences with a link strength of 16. This result (Pierre et al., 2022) proves that in developing countries, the role of digital technology is significant in improving the capabilities toward better performance. Meanwhile, other research in Cluster 1 stated that innovation bridges the relationship between technology and performance (Sarfraz et al., 2022). In Cluster 3, business strategy also has a significant effect on innovation (Valdez-Juárez et al., 2022). Some of the results can also be connected to Cluster 2, where women business owners in SMEs face limitations in entrepreneurship due to resource constraints, socio-cultural factors, knowledge, and skills (Lim et al., 2022).

The overview of previous research in cluster 5 can be explained with a research model that examines the impact of technology implementation using the moderating variable of the creative industry (Pierre et al., 2022). Meanwhile, other research explains the relationship between innovation and company performance (Sarfraz et al., 2022; Valdez-Juárez et al., 2022). The results of the three research can be developed into a new model by testing the moderating impact of the creative industry using relevant theories.

Cluster 6: In Cluster 6, there are 3 keywords, namely *open innovation*, *hotel*, and *knowledge management*, but *open innovation* has the most occurrences and link strength. Therefore, the implementation of open innovation depends on the strategy used, company type, and collaboration with external partners (Pilav-Velic & Hatidza, 2021). Open innovation supported by human capital can create additional opportunities for acquiring new knowledge and ideas bridging digital gaps (Kurmanov et al., 2022). Other research examined the innovation process in hotels, showing that the COVID-19 pandemic was not a trigger for innovation but inhibitions (Pasciaroni et al., 2022). Some of these results connect entrepreneurship and knowledge sharing in Clusters 5 (Maryia & Maribel, 2022) and Clusters 4 (Carlos et al., 2022). A more detailed explanation of this cluster's potential is combining the strategy impact model on innovation (Pilav-Velic & Hatidza, 2021) which incorporates with gender (Maryia & Guerrero, 2022).

Cluster 7: Based on the visualization in Cluster 7, the keyword *innovation* appears with a total of 33 links, connected to various keywords such as *competitiveness* and *fintech*. Results in this cluster include research on innovation in both large and small companies by (Al-Mannaie et al., 2023; Carvache-Franco et al., 2022). Other results regarding eco-innovation prove that government support enhances innovation capability, but market performance weakens the relationship (Sinatoko Djibo et al., 2022). In line with research in Malaysia, innovation is influenced by digital capability, government support, entrepreneurial orientation, and entrepreneurial leadership, supporting competitiveness and supply chain resilience (Al-Hakimi et al., 2021; Teoh et al., 2023). Results in this cluster can be further developed by connecting with other keywords in Cluster 3, such as *sustainability* (Amoah et al., 2023), *business strategy* (Valdez-Juárez et al., 2022), and *competitive advantage* (Budiarto et al., 2023). Based on the results of previous research with quantitative methods, a new model can be presented by combining factors that impact innovation, such as knowledge (Al-Mannaie et al., 2023); entrepreneurial orientation (Al-Hakimi et al., 2021); lack of information technology (Carvache-Franco et al., 2022); further connecting the concept with competitive advantage (Teoh et al., 2023) or sustainability (Budiarto et al., 2023).

Table 3. Number of Authors Based on Cluster

Clusters	Keywords	Authors
Cluster 1	Digital transformation; Digitalization; Digital economy; Digital capability; Business; Human capital; Internationalization	(Almatrodi & Skoumpopoulou, 2023; Alshaher et al., 2023; Bayudan-Dacuyucuy & Dacuyucuy, 2022; Bellakhal & Mouelhi, 2023; Blaszczyk et al., 2023; Budiarto et al., 2023; Chatterjee et al., 2021; Cvijić Čović et al., 2023; Grigorescu et al., 2023; Guanglin & Tao, 2022; Hart et al., 2022; John et al., 2023; Kaondera et al., 2023; Kurmanov et al., 2022; Naicker & Nsengimana, 2023; Othman et al., 2023; Oubrahim et al., 2023; Pierre et al., 2022; Rodchenko et al., 2021; Sarfraz et al., 2022; Savuth & Sothea, 2023; Shao et al., 2022; Stojanovska-Georgievska et al., 2022; Tazhibekova et al., 2023; Valiyev et al., 2022)
Cluster 2	SMEs; SEM; Artificial intelligent; TAM; Financial inclusion; E-commerce; Entrepreneurial orientation	(Akkad & Mouselli, 2023; Al-Hakimi et al., 2021; Alshaher et al., 2023; Bellakhal & Mouelhi, 2023; Budiarto et al., 2023; Chatterjee et al., 2021; Cvijić Čović et al., 2023; Eton et al., 2021; Faasolo & Sumarliah, 2022; Flores-Hernández et al., 2022; Gansonré & Ouédraogo, 2022; Justino et al., 2022; Kamdjoug, 2023; Kshetri, 2021; Larisa et al., 2022; Lim et al., 2022; Mahmutaj et al., 2021; Maryia & Maribel, 2022; Mishrif & Khan, 2022; Naicker & Nsengimana, 2023; Nan & Park, 2022; Nguyen et al., 2022; Qamar & Elmansori, 2021; Polas et al., 2022; Rajbhandari et al., 2022; Rodchenko et al., 2021; Sastararujji et al., 2022; Sharma et al., 2022; Smidt & Jokonya, 2022; Teoh et al., 2023; Thathsarani & Jianguo, 2022; Uzkurt et al., 2023; Valdez-Juárez et al., 2022; Vila, 2022; Zapata & Orellana, 2022)
Cluster 3	Circular economy; Competitive advantage; Business strategy; Sustainability	(Akberdina et al., 2023; Amoah et al., 2023; Budiarto et al., 2023; Faasolo & Sumarliah, 2022; John et al., 2023; Khodaparasti & Garabollagh, 2023; Sumo et al., 2022; Ureña-Espaillet et al., 2022; Valdez-Juárez et al., 2022)
Cluster 4	COVID-19; Challenges; Knowledge sharing	(Akkad & Mouselli, 2023; Almatrodi & Anshari, 2022; Bianchi & Machado, 2021; Bouzakhem et al., 2023; Carlos et al., 2022; Grigorescu et al., 2023; Mishrif & Khan, 2022; Naicker & Nsengimana, 2023; Nan & Park, 2022; Sastararujji et al., 2022; Shao et al., 2022; Teoh et al., 2023)
Cluster 5	Developing countries; Entrepreneurship; Economy growth	(Alawamleh et al., 2023; Chatterjee et al., 2021; Daka & Siad, 2021; Gansonré & Ouédraogo, 2022; Kshetri, 2021; Maryia & Maribel, 2022; Mohan et al., 2021; Pierre et al., 2022; Roopchund, 2023; Shkabatur et al., 2022; Zapata & Orellana, 2022)
Cluster 6	Open innovation; Hotel; Knowledge management	(Kurmanov et al., 2022; Metawa et al., 2021; Osorno-Hinojosa et al., 2022; Pasciaroni et al., 2022; Pilav-Velic & Hatidza, 2021; Schwartz et al., 2022)
Cluster 7	Innovation; Competitiveness; Economy development	(Al-Hakimi et al., 2021; Al-Manna'ei et al., 2023; Arman & Al-Qudsi, 2022; Bianchi & Machado, 2021; Carvache-Franco et al., 2022; Casadella & Tahí, 2021; Castella et al., 2022; Chemma, 2021; Daka & Siad, 2021; Larisa et al., 2022; Mahmutaj et al., 2021; Maryia & Maribel, 2022; Mohan et al., 2021; Rajbhandari et al., 2022; Ruba et al., 2023; Shkabatur et al., 2022; Sinatoko Djibo et al., 2022; Sumo et al., 2022; Susana et al., 2023; Teoh et al., 2023; Tychiev, 2022; Ureña-Espaillet et al., 2022; Valiyev et al., 2022; Vila, 2022)
Cluster 8	Technology; Fintech; Performance	(Ahmed et al., 2022; Bellakhal & Mouelhi, 2023; Dumenu et al., 2023; Justino et al., 2022; Lontchi et al., 2023; Mishrif & Khan, 2022; Mohamad et al., 2021; Nguyen et al., 2022; Pea-Assounga & Yao, 2021; Polas et al., 2022; Ruba et al., 2023; Thathsarani & Jianguo, 2022; Tychiev, 2022; Ureña-Espaillet et al., 2022)

Cluster 8: In Cluster 8, there are keywords such as technology, fintech, and performance, but technology has 16 occurrences with a link strength of 31. In this cluster, previous results (Lontchi et al., 2023) provided evidence that using fintech could directly enhance SMEs

performance through financial literacy. Furthermore, the implementation of technology, organizational factors, and the environment improve digital transformation toward better performance (Justino et al., 2022; Nguyen et al., 2022). Additional results also explain that digitalisation can increase sales and growth for SMEs (Bellakhal & Mouelhi, 2023). These present opportunities for future research when connected to cluster 7, which focuses on innovation (Al-Mannaie et al., 2023). The impact of technology and e-commerce on the relationship between the operations and performance of company is also stated (Mishrif & Khan, 2022). This result offers opportunities for further development by incorporating keywords such as competitive advantage and sustainability in cluster 3 (Budiarto et al., 2023). The explanation of the opportunities is to start from the various antecedent factors impacting the use of m-commerce in SMEs (Justino et al., 2022). This can be connected to competitive advantage and sustainability to obtain a new research model (Budiarto et al., 2023).

Table 4. Number of Occurrences and Link Strength

Clusters	Keywords	Occurrence	Total Link Strength
Cluster 1	Digital transformation	11	12
	Digitalization	6	12
	Digital economy	4	8
	Digital capability	2	5
	Business	2	4
	Human capital	2	4
Cluster 2	Internationalization	2	4
	SMEs	41	76
	SEM	6	12
	Artificial intelligent	3	7
	TAM	3	5
	Financial inclusion	3	5
Cluster 3	e-commerce	2	6
	Entrepreneurial orientation	2	4
	Circular economy	2	6
	Competitive advantage	2	6
	Business strategy	2	5
Cluster 4	Sustainability	2	5
	COVID-19	12	20
	Challenges	2	3
Cluster 5	Knowledge sharing	2	2
	Developing countries	7	16
	Entrepreneurship	6	12
	Economy growth	2	3
Cluster 6	Open innovation	5	7
	Hotel	2	4
	Knowledge management	2	4
Cluster 7	Innovation	21	33
	Competitiveness	2	5
	Economy development	2	1
Cluster 8	Technology	16	31
	Fintech	2	5
	Performance	2	4

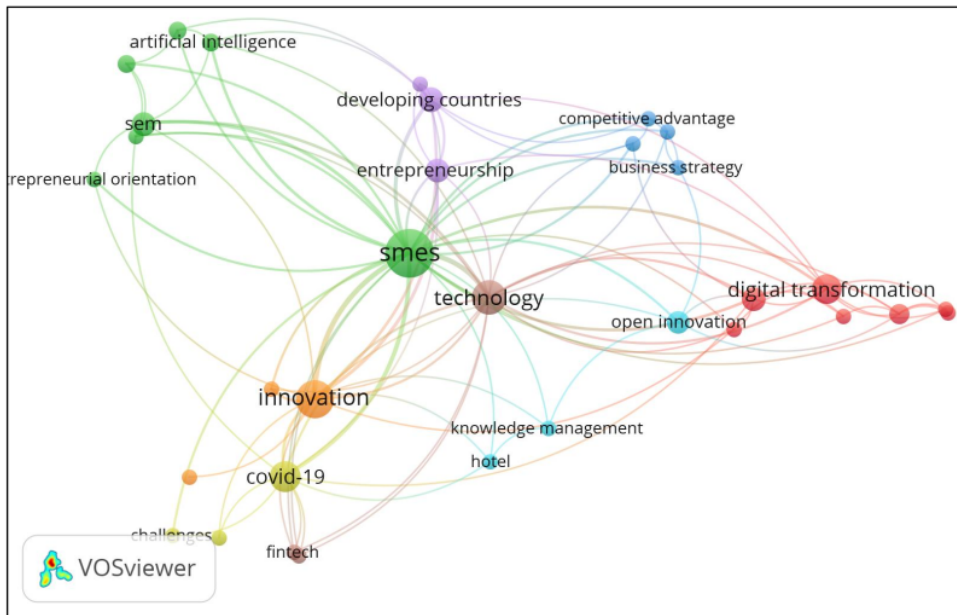


Figure 1 Analysis Results with Vos Viewer

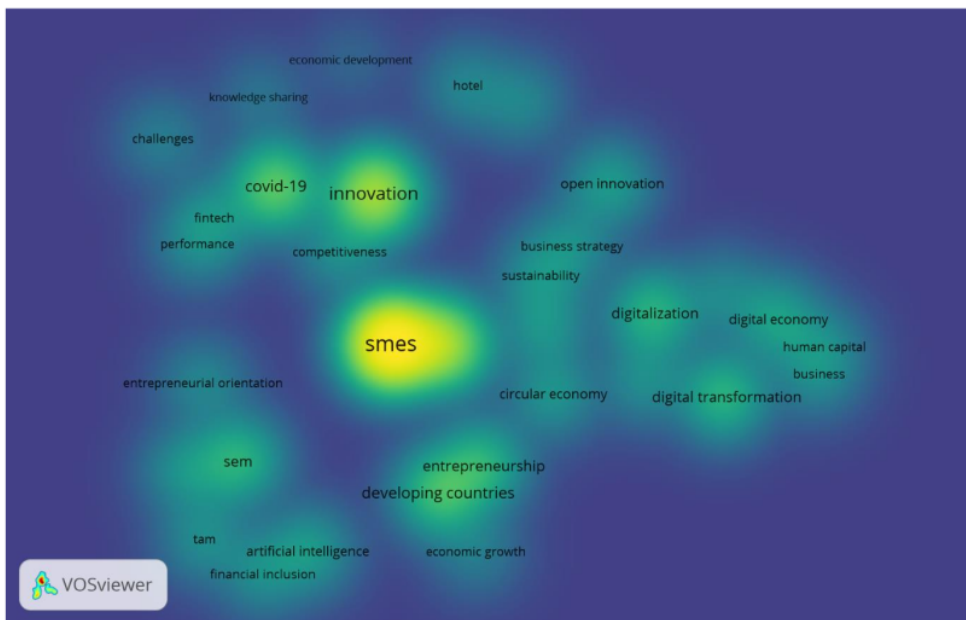


Figure 2 Density display result

Conclusions/Recommendations

In conclusion, the visualization results using Vos Viewer were indicative of the variable "SMEs" as the most frequently observed keyword across different articles. However, attention was provided to Clusters 7 and 4, where the keyword "economy development" and "knowledge sharing" had only 1 and 2 link strengths. These keywords served as entry points for the fields of technology, innovation, and digital economy. Furthermore, it is essential for researchers that innovation, technology, and digital transformation variables have become trends nowadays, so finding novelty in this area will be a difficult challenge. Finally, based on the analysis results in the figure, many variables still have no connection, making it an opportunity for future research, especially in developing countries. This research also presented several limitations considered for future analyses. First, there were no differences between subjects in low-income, lower, upper, or high-income countries, and future research could be tested based on income categories. This limitation was consistent with previous results that investing in infrastructure strengthened creativity and promoted innovation and technology adoption, which was a barrier for low-income countries (Al-Manna'ei et al., 2023; Bayudan-Dacuyucuy & Dacuyucuy, 2022). Second, this research did not differentiate the objects as small firms, large firms or government entities. This could be an opportunity for future research because small businesses have limited resources for innovation (Dumenu et al., 2023; Polas et al., 2022; Thatsarani & Jianguo, 2022). Lastly, this research uses several occurrences of keywords = 2, meaning keywords only used once did not appear in the analysis, such as e-government (Shao et al., 2022), start-up (Alawamleh et al., 2023), and digital education (Grigorescu et al., 2023). Finally, this research only discussed the definition of digital economy, which according to practitioners was still ambiguous. Therefore, future analyses could show the definition of digital economy from various perspectives based on 5 levels of digital development (Kurmanov et al., 2022).

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APPENDIX

No	Country	Author	Year of publication	Methodologies	Study Periods
1	Algeria	Chemma, N.	2021	Qualitative	Sept 2013 - Jun 2016.
2	Angola	Justino, M. V. et al.,	2022	Quantitative	NA
3	Argentina	Pasciaroni, C., et al.,	2022	Qualitative	July - Oct 2020
4	Azerbaijan	Valiyev, A., et al.,	2022	Qualitative	Jan - May 2021
5	Bahrain	Al mannaei, et al.,	2023	Quantitative	Jan - Feb 2022
6	Bangladesh	Polas, M. R. H., et al.,	2022	Quantitative	Feb - March 2022
7	Belarus	Maryia, A., & Maribel, G.	2022	Quantitative	2017-2018
8	Benin	Sinatoko, D., et al.,	2022	Quantitative	Jul - Sept 2021
9	Bolivia	Vila, A. A.	2022	Qualitative	2021
10	Bosnia	Pilav-Velic, A., & Hatidza, J.	2021	Quantitative	Okt - Dec 2019
11	Brazil	Carlos, et al.,	2022	Qualitative	During Covid Pandemic
12	Botswana	Chinaza, U.	2021	Qualitative	October 2021
13	Brunei	Almunawar, M. N., & Anshari, M.	2022	Quantitative	2021
14	Burkina faso	Gansonré, S., & Ouédraogo, S. A.	2022	Quantitative	2014
15	Cambodia	Savuth, C., & Sothea, O.	2023	Qualitative	NA
16	Cameroon	Lontchi, C. B., et al.,	2023	Quantitative	During Covid Pandemic
17	Chile	Zapata, I. E. T., & Orellana, O. V.	2022	Qualitative	2021
18	China	Guang-lin, X., & Tao, M.	2022	Quantitative	2008-2029
19	D. Rep. of the Congo	Kamdjou, J. R. K.	2023	Quantitative	Jan - March 2021
20	Ecuador	Carvache-Franco, et al.,	2022	Quantitative	2015
21	Dominican	Ureña-Espallat, H.J., et al.,	2022	Quantitative	2020
22	Egypt	Metawa, N., et al.,	2021	Qualitative	2019 - 2020
23	El salvador	Flores-Hernández, et al.,	2022	Quantitative	2018
24	Eswatini	Ahmed, J.U., et al.,	2022	Qualitative	2018
25	Ethiopia	Shkabatur, J., et al.,	2022	Qualitative	NA
26	Fiji	Sharma, S., et al.,	2022	Quantitative	Nov - Dec 2020
27	Gambia	Lim, S., et al.,	2022	Qualitative	NA
28	Ghana	Amoah, et al.,	2023	Quantitative	June - Sept 2022
29	India	Chatterjee, S.	2021	Quantitative	Dec 2019 - Jan 2021
30	Indonesia	Budiarto, D.S. et al.,	2023	Quantitative	Sept - Dec 2022
31	Iran	Khodaparasti, R. B., & Garabollagh, H. B.	2023	Quantitative	April - July 2022
32	Iraq	Alshafer, A. et al.,	2023	Quantitative	Feb - Nov 2021
33	Jordan	Alawamleh, M., et al.,	2023	Qualitative	During Covid Pandemic
34	Kazakhstan	Kumanov, N.	2022	Quantitative	2016 - 2021
35	Kosovo	Mahmutaj, L. R., et al.,	2021	Qualitative	2014-2016
36	Kuwait	Arman, H., & Al-Qudsi, S.	2022	Qualitative	2019 - 2021
37	Laos	Castella, J.C., et al.,	2022	Qualitative	2005-2020
38	Lebanon	Bouzakhem, N.	2023	Quantitative	Sept - Oct 2022
39	Liberia	Sumo, P. D., et al.,	2022	Qualitative	Nov 2021 - Feb 2022
40	Libya	Omar, H. F. H., & Elmansori, M. M.	2021	Quantitative	NA
41	Madagaskar	Hart, M. C. et al.,	2022	Qualitative	March - April 2022
42	Malawi	Dumenu, W. K., et al.	2023	Quantitative	June - August 2021
43	Malaysia	Teoh, M. F., et al.,	2023	Qualitative	Sept - Oct 2020
44	Mauritius	Roopchund, R.	2023	Qualitative	NA
45	Mexico	Valdez-Juárez, L. E., et al.,	2022	Quantitative	Feb - Oct 2021

No	Country	Author	Year of publication	Methodologies	Study Periods
46	Moldova	Larisa, M.	2022	Quantitative	2015-2020
47	Morocco	Oubrahim, I., et al.,	2023	Quantitative	Aug - November 2022
48	Nepal	Rajbhandari, S., et al.,	2022	Quantitative	March - Dec 2020
49	Nicaragua	Osorno-Hinojosa, R., et al.,	2022	Qualitative	2018-2021
50	Nigeria	Shamaki, H., et al.,	2022	Quantitative	January 2021
51	Nort macedonia	Stojanovska-Georgievska, L., et al.,	2022	Qualitative	2022
52	Oman	Mishrif, A., & Khan, A.	2022	Quantitative	During Covid Pandemic
53	Pakistan	Sarfraz, M., et al.,	2022	Quantitative	March - June 2022
54	Papua New Guinea	Ssemugenyi, F., & Nuru Seje, T.	2021	Quantitative	During Covid Pandemic
55	Peru	Pierre, S. L. J.	2022	Quantitative	2015
56	Philippines	Bayudan, C., & Dacuycuy.	2022	Quantitative	2019
57	Poland	Błaszczak, M., et al.,	2023	Quantitative	2016 - 2021
58	Qatar	Othman, A.	2023	Qualitative	2019-2021
59	Rep of the congo	Pea-Assounga, J.B., et al.,	2021	Quantitative	Oct - Dec 2019
60	Romania	Grigorescu, A. et al.,	2023	Quantitative	2008-2021
61	Russia	Akberdina., et al.,	2023	Quantitative	June - Nov 2022
62	Rwanda	Naicker, V., & Nsengimana, S.	2023	Qualitative	During Covid Pandemic
63	Saudi Arabia	Almatrodi, I., & Skoumpopoulou, D.	2023	Qualitative	May 2020
64	Senegal	Casadella, V., & Tah, S.	2021	Qualitative	NA
65	Serbia	Cvijić Čović, M., et al.,	2023	Quantitative	Feb - April 2020
66	Somalia	Daka, E., & Siad, S. A.	2021	Qualitative	NA
67	South africa	Smidt, H. J., & Jokonya, O.	2022	Qualitative	2021
68	South sudan	Kshetri, N.	2021	Qualitative	2019
69	Sri lanka	Thathsarani, U. S., & Jianguo, W.	2022	Quantitative	Sept 2021 - Jan 2022
70	Syria	Akkad, B. A., & Mouselli, S.	2023	Qualitative	During Covid Pandemic
71	Tanzania	Shao, D., et al.,	2022	Qualitative	Feb 2020 - Feb 2021
72	Thailand	Sastararuj, D.	2022	Qualitative	August 2020
73	Tonga	Faasolo, M., & Sumarlah, E.	2022	Quantitative	May-July 2021
74	Trinidad & Tobago	Mohan, P., et al.,	2021	Quantitative	2015
75	Tunisia	Bellakhal, R., & Mouelhi, R.	2023	Quantitative	March 2013 - July 2014
76	Turkey	Uzkurt, C., et al.,	2023	Quantitative	Oct - Dec 2021
77	Uganda	Eton, M.	2021	Quantitative	2018
78	Ukraine	Rodchenko, V., et al.,	2021	Quantitative	Nov 2020-Feb 2021
79	Uruguay	Bianchi, C., & Machado, M.	2021	Quantitative	2009 - 2015
80	Uzbekistan	Tuychiev, S.	2022	Qualitative	During Covid Pandemic
81	Vietnam	Nguyen, T. H., et al.,	2022	Quantitative	NA
82	Yemen	Al Hakimi., et al.,	2021	Quantitative	NA
83	Zambia	Nan, W., & Park, M.	2022	Quantitative	Sep 2019 - March 2020
84	Zimbabwe	Kaondera, P. R.	2023	Quantitative	2022

NA: We did not find the study periods

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